Sandia National Laboratories

Energy & Climate

Vision

To enhance the nation's security and prosperity through sustainable, transformative approaches to our most challenging energy and climate problems.

The Molten-Salt Test Loop at the National Solar Thermal Test Facility

The Molten Salt Test Loop is a unique facility to demonstrate thermal-storage components at power-plant scales before building an entire solar power plant. A cost-effective thermal storage system would transform solar energy from a source of intermittency that the grid must deal with to a remedy for rapidly fluctuating demand.

Renewable energy generation sources have begun to generate significant amounts of power for the national electricity grid. With the Molten Salt Test Loop (MSTL), Sandia and its industry partners are working to address a major barrier to cost-effectively incorporating more solar thermal power generation.

The national grid does not store large amounts of electricity. It is primarily generated as consumers demand it. One of the larger regular peaks in consumer demand occurs when we all go home from work and turn on our home appliances, air conditioners, and begin to cook dinner—after the sun has begun to set each day. Also, while solar thermal generating systems are less affected by intermittent cloudiness than photovoltaic systems, an overcast day can impair a generating station's ability to meet utility demand.

A cost-effective system for storing the thermal energy absorbed by the generating system while it is "on sun" and then delivering it to the utility as needed would transform solar energy from a source of intermittency that the grid must deal with to a remedy for rapidly fluctuating peaks in consumer demand. Concentrating solar power (CSP) receivers increasingly use molten salt to store heat generated by the sun. Molten salt is cheap, abundant, and easy to obtain, and it stores thermal energy for long periods, which provides greater flexibility for the electric grid.

Enter the Molten Salt Test Loop

Private companies are taking notice of solar thermal technology, but need a way to test components before investing up to $1B to build a CSP plant. Before designing a plant, users want to understand how the system will operate with liquid salt at ~1050 °F. They need to understand how the interaction of pressure, temperature, and flow rate will impact how the system operates.

The MSTL objective is to advance solar power-generation technology beyond any current existing low-temperature technology. The MSTL, commissioned in October 2012 at Sandia's National Solar Thermal Test Facility (NSTTF), was designed by Bridgers & Paxton Consulting Engineers, Inc. to provide three parallel test platforms for evaluating CSP collectors and

The Molten Salt Test Loop has three parallel test sections for simultaneous customer solar component testing. MSTL is the only test facility in the country that can provide real power-plant conditions and collect data about the interactions of pressure, temperature, and flow rates. (Photo by Randy Montoya)

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U.S. DEPARTMENT OF ENERGY

Sandia mechanical technologist John Kelton sifts through a bucket of salt beads before they are melted for use in MSTL. When a customer wants to test using MSTL, the vertical loop shown here is removed and the customer's experiment is put in place of the loop. Customer experiments can be as small as testing instrumentation on materials, or as large as on-sun testing of concentrating solar collection modules. (Photo by Randy Montoya)

power-plant-size components in flowing molten nitrate salt simulating solar power plant conditions. It is the only test facility in the world that can provide real power-plant conditions and collect data to help companies make commercial decisions.

Designed and built to exacting specifications, Sandia's MSTL system provides a means to reduce start-up risks to newly constructed generation facilities by performing accelerated lifetime testing on power-plant-size components to 585 °C in a molten nitrate salt environment.

The system circulates molten nitrate salts at

- flow rates of 50–700 gpm
- temperatures from 300 °C – 585 °C, and
- pressures of 75–625 psi.

No other test facility in the world is capable of supporting such extensive, large-scale research.

Through independently controlled parallel test-loop sections, multiple solar components can be simultaneously tested under varying solar-plant conditions. ***The MSTL directly supports the Department of Energy's SunShot goals by providing lower thermal-energy storage costs and greater collection efficiencies.*** "It really gives a complete picture of how the system will work on-sun," said David Gill, who leads thermal energy storage research at Sandia and oversaw the test loop construction.

AREVA Demonstration Project

AREVA's solar team and Sandia's molten-salt technology experts developed an innovative approach to energy storage that combines MSTL with AREVA's compact linear Fresnel reflector (CLFR) technology. The result is a reliable, competitive solution that optimizes CLFR technology benefits by ensuring that the energy harvested can be dispatched night or day through the use of molten-salt storage.

AREVA's molten salt energy storage demonstration plant installed at Sandia's National Solar Thermal Test Facility in Albuquerque, New Mexico.

The successful test results demonstrate that using molten salt as a working fluid enables high-temperature operations, reduces the salt volume needed for storage and removes the need for two sets of heat-exchangers in the system. These efficiencies decrease the overall system cost and complexity. As part of the project, AREVA will also study the optimization of operations and maintenance costs related to molten-salt management in a real-world environment.

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